

BRIEFING NOTES ON CLIMATE SCIENCE AND CLIMATE CHANGE

What do we mean by climate and climate change?

- Climate is the **average** of weather over time and across large regions, even the entire planet. Weather is what is happening in one place at one time.
- The global climate has always **varied** for many reasons, such as interactions between components in the climate system (oceans, atmosphere, ice sheets, etc.):
 - El Niño, a climatic phenomenon where the surface temperature of the eastern Pacific Ocean warms, affecting the weather worldwide, is an example of this.
- **Climate change**, on the other hand, occurs because the amount of energy in the entire climate system is changed which affects each and every component in the system.
 - Changes in the Earth's orbit, the energy received from the Sun and the amount of greenhouse gases in the atmosphere can all cause climate change.

How can humans cause climate change?

- Human activities such as burning fossil fuels increase the amount of CO₂ and other greenhouse gases in the atmosphere, enhancing the natural greenhouse effect. Increasing CO₂ causes the planet to heat up.
 - Ice cores show the concentration of CO₂ in the atmosphere has increased by at least 40% in the last 200 years since the Industrial Revolution. The last time CO₂ increased this much was over a 6,000 year period as the Earth came out of an ice age, and the average surface temperature rose by 5C.
- Burning fossil fuels and changes in land use, such as deforestation, have altered how much sunlight is reflected back into space (called the **albedo**).
 - Small particles like smoke and dust in the atmosphere (aerosols) can reflect sunlight and affect clouds.
 - The impact this has on the climate is only beginning to become clear, and is expected to feature prominently in the IPCC's 5th Assessment Report in 2014.

What effects will human activity have on the climate?

- It will get warmer, but the exact climatic effects of the recent dramatic increase in CO₂ are not certain.
 - So far we have seen an increase of 0.8C in the average surface temperature of the Earth since 1900, with melting in the Polar Regions and more frequent extreme weather.
- Simple calculations and our most complex models all agree: if we double CO₂ we will see an average warming of between 2 and 4.5C. In context, 4.5C is the difference between today and the deepest ice-age.
- Models of the climate system make varying predictions of future temperatures and other effects of climate change because of two major factors:
 1. **Climate sensitivity.** Once the climate begins to change, the effects of that change can lead to further changes (called '**feedback**'). This makes exact effects hard to predict. So if we double CO₂, we cannot know exactly what the average increase in temperature will be.
 2. **Future emissions.** We don't know how successful we will be in reducing greenhouse gas emissions.

Why does climate change matter?

- Small changes in average temperature can translate to big changes across the planet, leading to rising sea levels, more extreme weather and some areas becoming much harder to live in.
- Plants, animals, humans and societies have developed in a climate that has varied only a little, except over extremely long timescales: we are not adapted to cope with rapid climate change.

See overleaf for common misconceptions about climate change

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Common misconceptions about climate change

‘Not all scientists think man-made climate change is real’

The vast majority of climate scientists agree on the fundamentals of human-induced climate change, though there is healthy debate about the extent of change and what to do about it. Just as with smoking and lung cancer, the weight of evidence strongly suggests that human factors have caused and will cause climate change. All national academies of science agree on the existence of man-made climate change, while most scientists who disagree work outside climate science.

‘Climategate’ and scientific misconduct: Three independent inquiries into the release of hacked emails from the University of East Anglia, which were used to suggest global warming was a scientific conspiracy, recommended greater transparency by UEA but found nothing wrong with the science.

‘The UK has had cold winters and poor summers’

Weather is not climate and we must look at averages. It is risky to jump to conclusions about climate change by looking at small areas like the UK. At the global level, local variations average out and it is easier to make clear statements. Nonetheless, 7 of the 10 warmest years in the UK since 1910 have occurred between 2001 & 2012.

Extreme weather: Climate change also raises the likelihood of extreme weather events. For instance, floods which we have come to expect once in 100 years are now likely to be seen once in 10 years and severe thunder storms are 20% more likely than 20 years ago. This is supported by observations.

‘There has been no global warming since 1998’

1998 was a particularly warm year so is an unfair place to start measuring recent trends. But every decade since the 1950s has seen warming and 2000-2009 was around 0.15C warmer than 1990-1999. Temperature fluctuates naturally, but the general trend is upwards and it moves in a series of jumps. However, the rate of rise does appear to have slowed in the last decade and we don’t yet know exactly why.

‘Climate change has happened before’

Variations in the climate have occurred, such as the Medieval Warm Period and Little Ice-Age. There could be various causes, e.g. solar activity. But that does not change the fact that more CO₂ will cause warming.

‘Warming is causing more CO₂, not the other way round’

Ice-core records do indeed show that CO₂ levels rise when the Earth comes out of an ice-age. However, warming and CO₂ levels cause each other, so if either happens the other will follow.

‘We’re doomed, and there’s nothing we can do about it’

Some claims about the severity of climate change have gone beyond hard evidence. For instance, climate change has been speculatively linked to high numbers of deaths, and it has been claimed we are close to catastrophic ‘tipping points’. While tipping points are genuine scientific possibilities they are hard to predict with any certainty. Meanwhile, there is much we can do to prepare for and to slow climate change.

‘Climate change will have some good effects’

Small increases in CO₂ may increase crop yields but larger increases will affect which crops can grow. Some colder areas will become more pleasant, but such benefits will be outweighed by rising seas, heat and drought.

What does the future hold?

How the climate changes in the future will go beyond what we have already seen and the largest effects will be in temperature-sensitive regions like the poles. Long timespans are needed to let the planet adjust. For instance, if the Greenland ice-sheet completely melts, sea levels will rise by many metres over an unknown length of time. As CO₂ levels increase, the risks associated with climate change become more serious.

Links to further information

Royal Society publication “Climate change: a summary of the science” published in September 2010. The guide summarises the current scientific evidence on climate change and its drivers, highlighting the areas where the science is well established, where there is still some debate, and where substantial uncertainties remain:

http://royalsociety.org/uploadedFiles/Royal_Society_Content/policy/publications/2010/4294972962.pdf

The Department for Business Innovation and Skills’ (BIS) webpages on climate science including sections: ‘Greenhouse effect’, ‘Human activities’, ‘The world is warming’, ‘Natural factors’, ‘Cause of recent warming’ and ‘Effect of rising greenhouse gas levels’:

<http://www.bis.gov.uk/go-science/climatescience>

Special report of the Intergovernmental Panel on Climate Change (IPCC) on extreme weather and climate change adaptation:

http://www.ipcc-wg2.gov/SREX/images/uploads/SREX-SPMbrochure_FINAL.pdf

FAQ from the IPCC’s 4th assessment report in 2007. The reports intended to assess scientific, technical and socio-economic information concerning climate change, its potential effects, and options for adaptation and mitigation:

<http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-faqs.pdf>

“Explaining extreme events of 2011 from a climate perspective” which came as a supplement to the American Meteorological Society’s State of the Climate Report 2011:

<http://journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-12-00021.1>

Highlights of the American Meteorological Society’s State of the Climate Report 2011:

<http://www.climatewatch.noaa.gov/article/2012/state-of-the-climate-in-2011-highlights>

These Briefing Notes have been written by the Science Media Centre in consultation with a number of scientists, science press officers and broadcast journalists. They are not intended as a comprehensive summary on a subject, but rather a snapshot of the basics, of points of controversy and a pointer towards sources of more detailed information. They are subject to change and will be updated as and when the science moves on.

For more information about our Briefing Notes, please contact the Science Media Centre on 020 7611 8300 or email smc@sciencemediacentre.org.